

ORIGIN OF THE EDIBLE BICOLOR-FRUITED CULTIVARS OF CUCURBITA PEPO

Harry S. Paris

Department of Vegetable Crops, Agricultural Research Organization,
Newe Ya'ar Experiment Station, P. O. Haifa, Israel

Bicolor-fruited cultivars of Cucurbita pepo L. are those with fruit rinds containing regions which are yellow or orange and green or black, the borders of which regions are sharp and distinct. The yellow/orange regions and the green/black regions are visible as distinct yellow and as distinct green regions, respectively, of the ovary from long before anthesis. The distribution of yellow is generally toward the equatorial regions and the distribution of green toward the polar regions in bicolor fruits.

The bicolor characteristic is conditioned by alleles at the B locus other than the wild-type allele for completely green ovaries, B+ (Shifriss, 1981). When homozygous, the B allele causes the ovary to be completely yellow from long before anthesis, or "precocious yellow". When heterozygous, this allele conditions either yellow or bicolor ovaries, depending on the presence or absence of genes extending the yellow-colored region (Shifriss and Paris, 1981). Other "weaker" alleles of B result in less extension of yellow, and thus, bicolor ovaries and fruits.

Cultivars and breeding lines having precociously yellow ovaries have become more numerous since the introduction of the first cultivar to carry the B allele, Golden Zucchini, in 1973. All of these cultivars can be traced to the stabilization of B in the ornamental cultivar Bicolor Pear by O. Shifriss and subsequent transfer of B to edible cultivars by himself and his students (Shifriss, 1965, 1981). However, these modern cultivars were preceded by the no longer extant and almost forgotten edible bicolor cultivars of 100 years ago, cultivars which were not directly involved with the development of the present-day edible cultivars carrying the B allele. My aim here is to review the descriptions of these obsolete cultivars, discuss how they probably differed from modern cultivars at the B locus, and offer a suggestion concerning their origin.

The most prominent of these cultivars was Cocoanut. As pointed out by Tapley et al. (1937), this is not to be confused with another cultivar of the same name of C. maxima that was described by Burr (1863), but rather that described by Goff (1888) and Gregory (1893). In Gregory fruits of this cultivar are illustrated, and the illustration is reproduced as Figure 1. From the illustration it is clear that the fruits of this cultivar were spherical like a pumpkin but furrowed like an acorn squash, predominantly light colored but striped and mottled with a darker shade in the furrows with the polar regions of the fruit of a distinct, much darker shade. The fruits of Cocoanut were described by Gregory as follows: "In beauty it excells every other variety

of squash. The color is an admixture of cream and orange, the latter color predominantly in the depressions between the ribs, while the bottom, over a circle of two or three inches in diameter is of a rich grass-green." The illustration and description leave no doubt as to this cultivar having been bicolor. According to Tapley et al. Cocoanut was an especially long-lived cultivar, having been introduced by J.J.H. Gregory in 1869 and offered by seedsmen until 1923.

Two other cultivars of that era can be inferred to have been bicolor from the descriptions by Tapley et al. (1937). Cv. Golden Heart was described as being similar to Cocoanut but heart-shaped, golden yellow with dark green stripes along the furrows and probably derived from Cocoanut. Cv. Illinois Beauty was described by Tapley et al. as being furrowed but elongate, and "Skin color at the ends is dark green and in the center is a broad definite band of orange-yellow."

Yet another cultivar, Variegated Bush Scallop, was suggested by Shifriss (1955) to have been bicolor. This is one possible interpretation of the short description of this cultivar by Tapley et al., who refer the reader to an illustration of fruits of this cultivar in Vilmorin (1883). From more detailed descriptions by Burr (1863) and Goff (1888) and from Vilmorin's illustration it is clear that this cultivar was striped, but not bicolor. Shifriss also mentioned another scallop, called Farr's Benning White Bush. Though there is nothing in the description of this cultivar by Tapley et al. to suggest it was bicolor, Shifriss (1955) stated that it was known to him personally as being truly bicolor. Possibly, the presence of green and yellow regions of the fruits was overlooked because of the pale pigmentation of this cultivar.

The bicolor cultivars Cocoanut, Golden Heart, Illinois Beauty, and Farr's Benning White Bush probably were homozygous for a weak allele of *B*. If they were both homozygous and bicolor, then they almost certainly did not carry the *B* of modern cultivars, the *B* allele having full effect (Shifriss and Paris, 1981).

C. pepo is of North American origin (Trumbull, 1876; Whitaker, 1947). Forms of *C. pepo* appeared in European herbals relatively soon after the first voyages to the New World. Pumpkin-type forms appeared first, in the herbal of Fuchs (1542), and these soon became common garden plants in the United Kingdom (Gerard, 1597; Plat, 1660). Soon after their introduction, the pumpkins were joined by scallop-type forms and an array of ornamental gourds, warted and non-warted (Parkinson, 1640; Bauhin, 1651; Dalechamps, 1653). A bicolor form, "*Cucurbita Mediocrocea*", was described by Bauhin (1651) as having both green and yellow regions, the yellow situated at the medial region of the fruit and the extent of the green and yellow regions varying greatly among fruits. The fruits were in addition described as having smooth, durable, hard rinds, suggesting a form of ornamental gourd. Both warted and non-warted bicolor gourds were described in detail by Lamarck

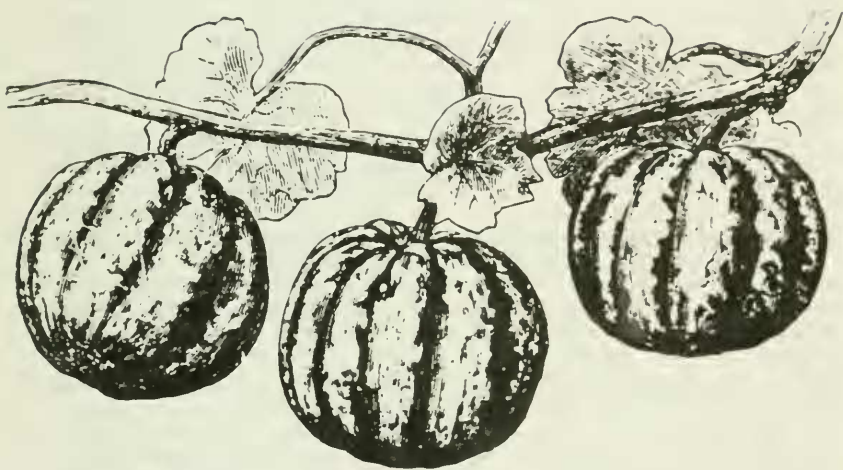


Figure 1. The Cucurbita pepo cultivar Cocoanut, reproduced from Gregory (1893).

citing Duchesne (1786). Naudin (1856) observed that the bicolor gourds were subject to what he called degeneration but nevertheless had been maintained in cultivation for a long time. Naudin (1860) illustrated two specimens of bicolor gourds, one quite similar or identical to Bicolor Pear and one somewhat more elongate. Alefeld (1866) offered the subspecific designation *C. pepo* var. *dimidiata* for the bicolor gourds but Bailey (1929) later included all ornamental gourds of *C. pepo* in var. *ovifera* Alefeld.

The ornamental gourds, *C. pepo* var. *ovifera*, are completely cross-fertile with the edible forms. It seems likely that soon after their introduction into Europe they had plenty of opportunity to cross-pollinate with edible forms, as both were commonly grown in gardens (Miller, 1732). Indeed, Shifriss (1965) has suggested that some ornamental gourd cultivars, e.g. Crown of Thorns, resulted from chance crosses between edible and ornamental forms. Some edible forms may also have resulted from such chance crosses. Cocoanut appears to have been a derivative of such a cross. Both Bicolor Pear gourd and an acorn type (top-shaped, furrowed fruits) of squash are illustrated in the same plate by Naudin (1860). The fruits of the two forms have novel characteristics, such as the distinct green and yellow regions of Bicolor Pear and the dark striping along the furrows of the acorn, which when combined could have produced fruits like those of Cocoanut. Had both Bicolor Pear and the acorn form been grown in the same garden during the same season, a definite possibility, they would have had ample opportunity to have been cross-pollinated, naturally or artificially. As this article by Naudin was published in 1860 but had been prepared by 1858, the cross-pollination probably took place in 1857. It is perhaps significant that Cocoanut was introduced into commerce a mere 12 years later, yet 12 years is an adequate amount of time for the development of a new pumpkin or squash cultivar.

Cocoanut and its allied furrowed and bicolor cultivars have been the focus of discussion here. Other, less well documented bicolor cultivars may have existed. For example, Shifriss (1965) presented a photograph of bicolor squash fruits he obtained from Mexico. The fruits were intensely pigmented and elongate, but not furrowed. In addition, he cited the red and white funerary vases of the Indians of 1500 years ago as possibly modeled after bicolor crookneck-type squash. There is also the bicolor scallop-type, Farr's Benning White Bush. Considering the great differences in fruit shape among these bicolor forms, it appears quite likely that the bicolor mutation (B+ to weak B) occurred on several occasions. It is also likely that both, the furrowed bicolor cultivars of the 19th century and the precociously yellow cultivars of the 20th century, were derived from the mutation that occurred in the ornamental cultivar Pear.

REFERENCES

- Alefeld, F. 1866. Landwirtschaftliche Flora, pp. 212-227. Wiegandt and Hempel, Berlin.
- Bailey, L.H. 1929. The domesticated Cucurbitas. Gent. Herb. 2: 62-115.
- Bauhin, J. 1651. Historia plantarum universalis, Volume 2, pp. 218-231. L.A. Graffenried, Yverdon, Switzerland.
- Burr, F. Jr. 1863. The field and garden vegetables of America, pp. 200-228. Crosby and Nichols, Boston.
- Dalechamps, J. 1653. Histoire generale des plantes, Volume 1, pp. 521-531. Borde, Arnaud and Rigaud, Lyons.
- Fuchs, L. 1542. De historia stirpium, pp. 698-699. Basel.
- Gerard, J. 1597. The herball or generall historie of plants, pp. 762-779. E. Bollifant, London. Republished 1974, Theatrum Orbis Terrarum, Amsterdam.
- Goff, E.S. 1888. Report of the horticulturist. Ann. Rep. New York St. Agric. Exper. Sta. (1887) 6: 76-306.
- Gregory, J.J.H. 1893. Squashes: how to grow them. J.J.H. Gregory, Marblehead, MA. 94 pp.
- Lamarck, J.B.P.A. de M. de. 1786. Encyclopédie Methodique, Botanique 2: 148-159.
- Miller, P. 1732. The gardeners kalendar. C. Rivington, London. 252 pp.
- Naudin, C. 1856. Nouvelles recherches sur les caractères spécifiques et les variétés des plantes du genre Cucurbita. Ann. Sci. Nat., Bot., ser. 4, 6: 5-73, 3 plates.
- Naudin, C. 1860. Les courges; leurs espèces et leurs variétés. Flore des Serres et des Jardins de l'Europe 12: 113-125, 1 plate.
- Parkinson, J. 1640. Theatricum botanicum, pp. 768-771. T. Cotes, London.

- Plat, H. 1660. The garden of Eden. Or an accurate description of all flowers and fruits now growing in England. W. Leake, London. Part 1, 175 pp. Part 2, 159 pp.
- Shifriss, O. 1955. Genetics and origin of the bicolor gourds. J. Hered. 46: 213-222.
- Shifriss, O. 1965. The unpredictable gourds. Am. Hort. Mag. 44: 184-201.
- Shifriss, O. 1981. Origin, expression, and significance of gene B in Cucurbita pepo L. J. Am. Soc. Hort. Sci. 106: 220-232.
- Shifriss, O. and H.S. Paris. 1981. Identification of modifier genes affecting the extent of precocious fruit pigmentation in Cucurbita pepo L. J. Am. Soc. Hort. Sci. 106: 653-660.
- Tapley, W.T., W.D. Enzie, and G.P. Van Eseltine. 1937. The vegetables of New York, Volume 1, Part 4. J.B. Lyon, Albany, New York, 131 pp.
- Trumbull, J.H. 1876. Vegetables cultivated by the American Indians. Bull. Torrey Bot. Club 6: 69-71.
- Vilmorin, A. 1883. Les plantes potagères, pp. 169-191. A. Vilmorin, Paris.
- Whitaker, T.W. 1947. American origin of the cultivated cucurbits. Ann. Missouri Bot. Gard. 34: 101-111.

ACKNOWLEDGEMENTS

Contribution No. 1772-E, 1986 series, from the Agricultural Research Organization, Bet Dagan, Israel. This research was conducted while the author was on sabbatical leave at the Vegetable Crops Department, University of Florida, Gainesville. He thanks D. J. Cantliffe, Chairman, for hosting him and S.C. Simonds for assistance with the photography. The author also thanks L. Lynas of the New York Botanical Garden Library for providing access to and photocopies of reference material used in this study.